



Report

COSPAR Workshop on Ethical Considerations for Planetary Protection in Space Exploration

Princeton University

Princeton, New Jersey

8-10 June 2010

Prepared for the COSPAR Panel on Planetary Protection

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Editors

May 2012

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COSPAR Workshop on Ethical Considerations for
Planetary Protection in Space Exploration

held under the auspices of the
Committee On Space Research (COSPAR)
of the
International Council for Science (ICSU)
at

Princeton University
Princeton, New Jersey, USA

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COSPAR
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With thanks to



Catharine Conley, Planetary Protection Officer



Gerhard Kminek, Planetary Protection Officer

and



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COSPAR Workshop on Ethical Considerations for Planetary Protection in Space Exploration

Executive Summary

The COSPAR Workshop on Ethical Considerations for Planetary Protection in Space Exploration was convened at Princeton University, Princeton, New Jersey on June 8-10, 2010. The invited participants comprised 26 individuals selected for their combined expertise and experiences in areas relevant to space science and exploration, ethics, law, policy, diplomacy, and communications. The Workshop agenda and list of participants are presented in Appendices A and C respectively.

The overall goals of the workshop were as follows:

- Determine whether PP measures and other practices should be extended to protect other aspects of planetary environments within an ethical and practical framework that goes beyond “science protection”
- If so, what would be bases for such policy and ethical framework? and
- What other implications and responsibilities are engendered when seeking to explore outer space in a manner that avoids harmful impacts on potential indigenous biospheres and other aspects of a planetary body?

After intense discussions in two parallel groups and subsequent plenary deliberations, workshop participants approved the following overall recommendations (arranged topically):

1. An expanded framework for COSPAR Planetary Protection policy/policies is needed to address other forms of “harmful contamination” beyond what is currently addressed (i.e., biological and organic constituent contamination). Such policy framework should be developed within the scope of the U.N. Outer Space Treaty (including Article IX on harmful contamination).
2. COSPAR should maintain the existing, effective planetary protection policy virtually intact while examining in parallel how to address issues of ethical considerations related to life, non-life, environmental management and multiple uses.
3. COSPAR should add a separate and parallel policy to provide guidance on requirements/best practices for protection of non-living/non-life-related aspects of Outer Space and celestial bodies.
4. COSPAR should consider that the appropriate protection of potential indigenous extraterrestrial life shall include avoiding the harmful contamination of any habitable environment—whether extant or foreseeable—within the maximum potential time of viability of any terrestrial organisms (including microbial spores) that may be introduced into that environment by human or robotic activity.
5. To begin the process of integrating ethical considerations into COSPAR Planetary Protection Policy, the group recommended that specific wording be added to the

COSPAR preamble and policy on planetary protection related to life and non-life, biological planetary protection, and environmental disturbances.

6. To make progress towards the parallel policy described above, there should be continued study over the next several years to identify useful management options and governmental mechanisms for establishing a framework for environmental stewardship on celestial bodies that could incorporate scientific input on one end, and enforcement on the other, considering possible features such as:
 - Environmental impact assessments for screening activities on celestial bodies
 - An intergovernmental mechanism for management of space exploration and use
 - Ensuring that COSPAR and other groups have input on management guidelines through a scientific committee providing advice to a Convention or appropriate process/structure
 - Possible designation, establishment and monitoring of planetary parks and areas for other uses, both protected and not-protected, and
 - Determine the appropriate jurisdiction over planetary ecosynthesis or other atmosphere-modification schemes, where science and other uses might be threatened or in conflict.
7. COSPAR should set up a group (or future workshop) to further explore the ethical values (e.g., intrinsic and instrumental) that apply to life, non-life, and environments as well as to the different classes of target objects in our solar system in order to provide guidance for balancing the different interests. Additional details on what this workshop comprises will be developed at future COSPAR Assemblies. During this period when COSPAR is reanalyzing PP policy, a conservative approach to decisions regarding space exploration and activities is warranted.
8. COSPAR should elaborate on management guidelines in interaction with organizations such as IISL and others, to establish a framework for environmental stewardship on celestial bodies for submittal to the UN COPUOS for UN General Assembly consideration. This should apply additionally to the accepted regulations for preventing harmful planetary contamination, which currently only consider biological and organic chemical contamination. This could include the establishment of an intergovernmental mechanism and/or body to provide for regulation of space exploration and use.
9. COSPAR should encourage its members and the associated states to undertake public dialogue and engagement efforts at the national and/or regional level concerning ethics in space exploration, with the ultimate purpose of having public sentiment (including public perception) integrated appropriately into COSPAR policy deliberations. In addition, COSPAR should ask the PPP and PEX panels to hold a workshop on public engagement, consultation, and participation in policy-making in order to inform members about the premises, principles, and purposes of public engagement activities and best practices.

1. Workshop Background and Logistics

Since the early days of space exploration and continuing after the adoption of the U.N. Outer Space Treaty (OST; 1967), the Committee on Space Research (COSPAR) has maintained a Planetary Protection (PP) Policy aimed at avoiding organic-constituent and biological contamination during space exploration. The policy incorporates suitably strict cleanliness and control measures to minimize contamination by spacecraft, equipment and activities, depending on their target locations and activities (COSPAR 2008). Historically, the rationale for the policy has been to avoid contamination of planetary environments by biological contaminants or terrestrial microbes that could compromise current or future scientific investigations, particularly those searching for indigenous life. At the time of the passage of the OST, there were no serious considerations of ethical concerns in the regulatory environment—indeed the field of environmental ethics on Earth didn't develop until years later, and the first discussions of space ethics, later still. (cf., Hargrove 1986)

Over the past several decades, robotic missions have greatly increased our understanding of diverse planetary landscapes and astrobiological research has altered our views about the survivability of terrestrial organisms in extreme environments. Together, this information has also expanded notions about the prospect of finding evidence of extraterrestrial life beyond Earth. As researchers recognized the increasing potential for discovery of verifiable extraterrestrial organisms, authors from diverse disciplines raised questions about ensuring environmental integrity as well as considering issues beyond science *per se*. They also suggested the need to examine what foundational ethical principles should frame our collective space activities and relationships as we explore celestial bodies beyond Earth (e.g., McKay 1990; Holmes 1986; Hargrove 1986; Lupisella and Logsdon 1997; Randolph et al. 1997; NRC 2000 p 13-14; etc.).

A 2006 National Research Council (NRC) study of forward contamination controls for Mars raised concerns about possible ethical issues associated with the introduction of terrestrial organisms into sensitive extraterrestrial environments, even when current planetary protection policy is followed and suitable controls are used. Although acknowledging that ethical issues were beyond the scope of the committee's work, it nonetheless recommended that ethical considerations be addressed at the earliest opportunity. The urgency of dealing with these ethical questions was underscored by uncertainty about the distribution of sensitive martian environments, the failure rates and cleanliness levels of past Mars landers, and the projected rapid pace of future spacecraft exploration. Thus the report's first recommendation focused on whether the purpose of planetary protection policy should include the safeguarding of indigenous life as well as protection of mission science.

Specifically, the report recommended that:

In light of new knowledge about Mars and the diversity and survivability of terrestrial microorganism in extreme environments, NASA should work with COSPAR and other appropriate organizations to convene, at the earliest

opportunity an international workshop to consider whether planetary protection policies for Mars should extend beyond protecting the science to include protecting the planet. This workshop should focus explicitly on (1) ethical implications and the responsibility to explore Mars in a manner that minimized the harmful impacts of those activities on potential indigenous biospheres (whether suspected or known to be extant), (2) whether revisions to current planetary protection policies are necessary to address this concern, and (3) how to involve the public in such a dialogue about the ethical aspects of planetary protection. (NRC 2006)

The NRC recommendation to convene an international workshop was followed by widespread discussion about ethical considerations, and subsequently endorsed by other group meetings, including NASA's PP Advisory Committee¹ (2007), ESA's PP Working group (2005), a COSPAR Planetary Protection Workshop in Montreal (January 2008), the COSPAR Planetary Protection Panel (PPP; July 2008), and other groups (e.g., IISL, PEX)².

The formal proposal to convene a workshop on ethical considerations and planetary protection was approved by the COSPAR Bureau and Council in 2008:

In light of new knowledge about planetary bodies and the diversity and capabilities of terrestrial microorganisms in extreme environments, and increasing activities in space exploration, it is recommended that COSPAR, working with the International Academy of Astronautics (IAA), the International Institute for Space Law, and other national and international institutions, seek the organization of an international workshop to consider whether biological planetary protection measures and other current practices intending to preserve planetary environments should be extended within a broader ethical and practical framework.

The Workshop topics should include examination of:

- Ethical implications and responsibility to explore outer space in a manner that avoids harmful impacts on potential indigenous biospheres;
- Whether revision to current planetary protection policies are necessary to address these concerns, beyond the current protection of science to include further protections of planetary environments; and
- How best to involve the public in such a dialogue about the ethical aspects of planetary exploration.

Ethical questions have continued to be of relevance in light of ongoing calls for one way and round trip missions to Mars and elsewhere in the solar system, as well as growing interest in human missions beyond low Earth orbit (LEO), and stepwise plans for

¹ The NASA Planetary Protection Advisory Committee (PPAC) was a precursor to the current NASA PP Subcommittee (PPS), which reports its findings to the NASA Advisory Council.

² ESA = European Space Agency; IISL = International Institute for Space Law; PEX = COSPAR Panel on Planetary Exploration; PPP = COSPAR Panel on Planetary Protection

commercial space activities on the Moon and other bodies. An international workshop provides an important forum for discussion of the current status of planetary protection provisions, and how they might be extended to include other considerations beyond strict science protection.

Tentative plans for the workshop envisioned a meeting of 20-30 scientists, mission planners, ethicists, policy analysts, lawyers and communications experts from the broadest possible suite of international participants, with an agenda to include both solicited contributions and invited talks from the participants, plenary deliberations, and ultimately, a published summary of the workshop findings and recommendations.

The COSPAR Workshop on Ethical Considerations for Planetary Protection in Space Exploration was convened at Princeton University, Princeton, New Jersey on June 8-10, 2010. The invited participants comprised 26 individuals selected for their combined expertise and experiences in areas relevant to space science and exploration, ethics, law, policy, diplomacy, and communications. The Workshop agenda and list of participants are presented in Appendices A and C respectively.

The overall goals of the meeting were outlined in a Workshop Charter (Appendix B), which sought to:

- Determine whether PP measures and other practices should be extended to protect other aspects of planetary environments within an ethical and practical framework that goes beyond 'science protection'
- If so, what would be bases for such policy and ethical framework? and
- What other implications and responsibilities are engendered when seeking to explore outer space in a manner that avoids harmful impacts on potential indigenous biospheres and other aspects of a planetary body?

2. Tutorial Summaries

The first day of the workshop centered on presentation in plenary session of tutorials to ensure that all participants were aware of important information prior to discussions and deliberations. Tutorial topics included information on planetary protection policy and implementation, relevant aspects of the NRC study that identified a need for the workshop, and overviews on space law, environmental protection, bioethics, and comparative systems of environmental management. Tutorials are summarized briefly below.

In his welcoming remarks, John Rummel began with an Introduction and Overview of the recommendations and deliberations by COSPAR and various groups that led to this workshop. He briefly discussed the planned workshop agenda and the need to consider *whether* and *how* to integrate both science and ethical perspectives in policies to protect environments and resources in Outer Space, while recognizing ongoing science exploration and increasing commercial interests in use and exploitation. He also

reviewed COSPAR policies of note, including those for protecting special regions on Mars and planetary protection guidelines developed for future human missions to Mars.

Chris Chyba discussed Prospects for Extraterrestrial Life in the Solar System, reviewing our scientific understanding of origin of life, potential habitability of different environments, and the basis for our current searches for extraterrestrial life. He also discussed various Solar System bodies and our knowledge of conditions on them that are relevant to their potential for harboring life.

Chris McKay took the long view in discussing planetary protection, noting potential challenges to planetary protection on Mars from activities that may arise in the not too distant future (i.e., sending life growth modules; establishing human bases with biological life support; proposals for planetary ecosynthesis and restoration; possible discovery of a second genesis). Each of these raises questions about the impact of contamination from deliberate human actions, and challenges us to consider both scientific and moral questions associated with PP policies. He argued for the notion of biologically reversible exploration as a way to avoid complications that would arise if and when we discover a second genesis of life. Questions about the moral status of alien microbes and ethical principles related to the value of life still need to be addressed.

Joanne Gabrynowicz provided information on Space Law and Protecting the Space Environment, giving an overview of the legal landscape associated with space exploration ranging from international treaties and instruments, to national laws and regulations, and specific agency policies. She reviewed the concept of space as a global commons (like Antarctica and oceans), and provided details on the Outer Space Treaty, its language, general focus, and Article IX, which includes planetary protection. She also discussed other US national laws and regulations of relevance to the space environment.

Armel Kerrest discussed the Antarctic Treaty, which can be viewed as an alternative model for environmental protection, with notable features and differences of relevance to the Outer Space Treaty. He reviewed the history of the Treaty and explained the various conventions and agreements related to conservation of resources, environmental impact assessments and protection and management of specially designated areas. While not a UN treaty, the Antarctic Treaty system provides numerous governance and management features that incorporate both scientific information and public input to assist in the planning and coordination of activities that both minimize possible conflicts and proactively address potential large scale environmental impacts.

David Paige summarized the findings of the 2006 NRC study focused on preventing the forward contamination of Mars (PREVCOM), which gave rise to the initial recommendation to examine ethical considerations in planetary protection policy. He reviewed the Committee's statement of task and participants, and its historical context, and key findings and recommendations. He concluded by focusing on notions of long

term sustainability and planetary ethics that are relevant to plans for exploring and utilizing planets and bodies in the solar system that have the potential for life, past, present or future.

Cassie Conley, NASA's Planetary Protection Officer (PPO) delivered a co-authored presentation (with Gerhard Kminek, ESA's PPO) that summarized information on the implementation of current PP policy on NASA and ESA missions. She reviewed COSPAR policies and the five PP categories that apply to different mission/target combinations and discussed the historical development of PP requirements from the Viking missions onward. Focusing on recent and planned robotic missions to Mars—both one way, and sample return-- she discussed the importance of bioburden reduction, the focus on preservation of science, the designation of Special Regions, and the 50 year time horizon for PP policy. She concluded by touching on PP issues relevant to future missions to outer planets and the conceptual and operations challenges ahead for human exploration.

John Rummel reviewed the Convention on Biological Diversity (CBD) which represents an example of blending both scientific and ethical concerns about conservation of genetic diversity, between-species diversity, and ecosystem diversity while balancing sustainable use, equitable sharing of resources, and responsible transfer of relevant technologies. Importantly, the Convention approach includes institutional and governance aspects, ongoing input from scientific research and expert advisory bodies, and mechanisms for governance and financial support for projects. The CBD is a model of effective international conservation and preservation of resources that includes science-supported strategic planning, attention to cross-cutting needs of diverse stakeholders, and proven institutional governance and guidance at the national, regional, and international levels.

Gerda Horneck outlined the thinking behind recent proposals for creating a planetary park system for the Moon, Mars and beyond (with co-author Charles Cockell). In analogy to National Park systems existing on Earth, a planetary park system could extend the reasons for practical protection policies beyond the utilitarian protection of scientific resources emphasized by planetary protection, into other utilitarian and intrinsic value arguments. Such planetary park systems could still allow for the development of non-park areas by commercial enterprises, while incorporating regional protection for other objectives (i.e., scientific interest and use; preservation of historic value or natural beauty; or preservation for future generations). Thus, a strategy of planetary parks for the Solar System could help solve future potential use conflicts, incorporate both utilitarian and intrinsic value arguments, and be organized under a single management system with clear regulations for protection and use. Such an approach also addresses considerations about moral and legal definitions of wilderness on other planetary bodies and would allow us to express a respect for other worlds

Carol Cleland presented a review of various ethical considerations in space exploration of relevance to the anticipated discussions at the workshop. She began with an overview of ethics and its three main branches (meta-ethics, normative, and

descriptive), followed by brief descriptions of moral status vs. agency and the development of three historical theoretical theories (consequentialism, deontology, and virtue ethics). She then gave a series of examples illustrative of the co-dependence of ethics and scientific knowledge, focusing on humans, other living things, non-biological beings and objects. She also described the historical development of environmental ethics and various possible positions that may be adopted. She concluded with a list of ethical issues likely to arise in discussions of space exploration.

Pascale Ehrenfreund described a recent project and report by COSPAR's PEX on Stepping Stones Toward International Space Exploration, which recognizes the need to acknowledge the major stakeholders in space exploration (science, public, government, industry). She described the considerable work of various study groups in examining how to develop worldwide space exploration programs while safeguarding the scientific assets of solar system objects. After providing details about various missions and their science objectives, she explained how they can serve as stepping stones toward global space exploration by providing important information about environments, instruments, technology and networks needed to bridge between space faring nations and other stakeholders. International planetary exploration can be viewed as contributing not only to science understanding, but also to capacity building, thereby representing an opportunity to encourage public participation in policy and planning for future space exploration.

3. Subgroup Discussion Summaries

The second day of the workshop was devoted primarily to discussions in two separate sub-groups, each led by a designated chairperson. In addition to being guided by the Workshop Charter, subgroups were asked to consider the following questions:

- In addition to the current COSPAR planetary protection policy's protection of biological/ organic-constituent science opportunities, should we conduct solar system exploration to minimize or eliminate other possible negative effects on those bodies, e.g., on:
 - Potential (but currently undetected) indigenous biospheres in the farther future (>500 years)?
 - Non-living aspects of a body that do not affect scientific study (e.g., historical, scenic, etc.; which?)?
 - Other aspects of preservation/stewardship that would make sense to extend into the rest of the solar system?
- Which ethical constructs support/require the additional protections? Which might argue against them?
- What revisions or additions to current COSPAR planetary protection policies would be necessary to address these additional considerations/protections?
- Would a convention on planetary protection/harmful contamination extending Article IX of the UN Outer Space Treaty (in the manner of the Convention on Biodiversity) be feasible/desirable as a way to provide for elaborations of expanded planetary protection policies?

- How should we best provide for public engagement with solar system exploration, and involve the public in a dialogue about the ethical aspects of planetary protection?
- What revisions or additions to current planetary protection policy should be considered in support of such a broader engagement/dialogue, if any?
- Is now a good time to be working on this? If not, then when?

Both subgroups reported tentative findings in a plenary session at the end of the second day and resumed their separate deliberations the following morning to refine and update their reports and suggestions. In addition, since both groups agreed on the importance of communicating to the general public about the ethical aspects of planetary exploration, two participants with communications expertise (one from each subgroup) were asked to draft a uniform set of communications recommendations for plenary consideration.

Workshop participants were divided into the two subgroups in advance so that each group comprised similar expertise. Each subgroup determined on its own what questions or topics to emphasize, and what approach to take in addressing the workshop charter and questions. The complete reports of each subgroup as well as the joint communications group are included in Appendices D and E, and summarized below.

3.1 Subgroup 1: M. Race, Chair

Subgroup 1 selected five main questions from the assigned subgroup charter list and took a detailed, step-wise approach to their examination of ethical principles and needs. The group maintained a focus on operational concerns and considered when and on whom various aspects of policy might apply. The in-depth discussions addressed the following topics:

- Looking beyond current PP Policy and biological/organic contamination
- What ethical principles/constructs apply? What needs protection?
- Possible Revisions to COSPAR PP policies?
- Is now the time to do this?
- What about Public Engagement & Dialogue?

Discussions began with a detailed examination of ethical foundations, the wide range of approaches used in various situations, and recognition of important language differences from scientific and ethical perspectives (e.g. life as a contaminant vs. life as something of value). The group agreed that considerably more analysis of comparative fundamentals was needed before dealing with the complexity of space ethical issues.

The group then worked on formulating very specific wording that could be used to acknowledge ethical 'value' for both life and non-living things in the context of space exploration, COSPAR and the OST.

In answering their assorted questions, the group stressed the need to make revisions to COSPAR policy, and *not* to the OST legal regime. Furthermore, members urged that ethical issues be addressed now, before putative extraterrestrial life is discovered and/or there is an increase in the types and numbers of activities on celestial bodies. The group recognized that there are numerous procedural ways to deal with the ethical/policy issues ahead, and suggested the need for further study (rather than selecting a single approach like a Convention at this time). Finally, the group acknowledged the importance of public engagement and dialogue, but urged that proactive steps be taken at national levels, rather than making any changes to COSPAR international policy regarding public communication.

On the matter of very long term (>500 years) changes to planetary environments and habitability, the group opted to defer discussion of the topic to the plenary session, and perhaps beyond.

3.2 Subgroup 2: G. Horneck, Chair

In addressing the same questions and topics, Subgroup 2 took a different approach. While acknowledging that many ethical perspectives and approaches could be used, the group began by developing a preamble with consensus definitions of intrinsic and instrumental worth/values, and urged that a precautionary approach be built into any revisions to COSPAR PP policy. The group indicated the need for comprehensive, phased policies for pre- & post-landing, & post-discovery; and a balancing of stakeholder interests—considering a range of intrinsic & instrumental values.

The subgroup focused mainly on an operational approach, outlining suggested ethical considerations for different target bodies of concern to PP policy. The bodies fall into three main categories, which were discussed in light of instrumental and intrinsic ethical values, as well as issues needing further attention. Elaborating on each category, the group proposed a possible scheme for Implementation of Ethical Considerations as follows:

- **SS Bodies with no indications of indigenous life**
 - Bodies/ environments have various instrumental values (historic, scientific, aesthetic, commercial, etc.) and there may be need to consider relative value
 - Targets- ex., Moon, NEOs³, Mars' moons, Mercury
 - Measures- Stewardship; Consider preserve body vs. regions
- **SS Bodies with potential of extant/extinct life**
 - ET life & ecosystems have intrinsic value; also instrumental values
 - Targets- ex., Mars, Europa, Enceladus, Ganymede, TBD
 - Measures- Consider environmental stewardship & preservation regulations until bodies are explored sufficiently; Consider preserve body vs. regions;
- **SS Bodies where Humans Go**

³ NEO's: Near Earth Objects- hazardous asteroids and comets

- Have potential intrinsic & instrumental values; Diverse stakeholders
- Targets: Moon, NEOs and Mars, Mars' moons
- Measures: Need Human PP Protocol; Phased environmental management protocols; Develop *Pre-* and *Post-Detection* Policies as needed; Designate special areas; consider telerobotic exploration as PP strategy; and address quarantine, co-existence, in situ resource utilization (ISRU) & other issues, etc.

Subgroup 2 also discussed and acknowledged the importance of public engagement and dialogue regarding planetary protection and ethical considerations. It also suggested that any communication strategy should focus on encouraging members and states to undertake public consultation & engagement at national or regional levels.

In discussing Legal Aspects, the group suggested that existing treaties should not be modified, and that changes to policy should build on provisions already in the Outer Space Treaty (e.g., Article VI on liability and Article IX on harmful contamination). The group also endorsed the requirement of environmental impact assessments for all activities on celestial bodies, and the establishment of intergovernmental mechanisms or a new body to manage exploration & use (similar to interagency debris coordination: UNOOSA 2010)

Finally, Subgroup 2 proposed bringing four topics to the plenary discussions:

- Need for a COSPAR workshop to further explore ethical values
- Endorse adoption of the Precautionary Principle: investigate before any interference that could cause harm on celestial bodies
- COSPAR should elaborate on management guidelines, draft regulations, and a framework for environmental stewardship that goes beyond current policies for biological and organic constituent contamination avoidance. Policies and guidelines should address stewardship strategies for pre-landing, post-landing and post-discovery phases on various target bodies, and should encompass and balance a diverse set of stakeholder interests represented by a range of intrinsic and instrumental values.
- Need for a workshop to explore how to encourage public dialogue, consultation & engagement

4. Synthesis of Subgroup Findings and Plenary Deliberations

All workshop participants reassembled on the afternoon of Day 3 for a final plenary session to synthesize findings and develop final recommendations. The discussions were moderated by John Rummel, who began by reviewing the workshop charter and related topics and the initial subgroup questions, along with the policy, legal and ethical landscapes developed by each subgroup.

In the plenary discussions, participants of both subgroups summarized their views, identified areas of agreement for each topic, explored alternative acceptable steps for possible policy revisions, identified issues that need further attention, and developed consensus workshop recommendations, which were voted upon by all participants. The section below provides a question-by-question overview of perspectives, issues and suggestions discussed during the plenary session, all of which fed into the ultimate consensus recommendations.

Question 1. In addition to the current COSPAR planetary protection policy's protection of biological/ organic-constituent science opportunities, should we conduct solar system exploration to minimize or eliminate other possible negative effects?

Both subgroups responded in the affirmative to the question of whether we should conduct Solar System exploration in ways that minimize or eliminate other possible negative effects on celestial bodies (beyond prevention of biological contamination). Each subgroup agreed that it was important to first start with baseline ethical approaches and constructs as they apply to living and non-living entities on Earth, and to draw from considerations of stewardship and protection on Earth. Both groups also agreed that considerably more discussion is needed on the questions of how the ethical principles used on Earth would apply in the context of outer space and to the varied future scenarios and activities by different sectors (science vs. other activities, governmental and non-governmental).

The groups considered the question in two very different ways. Subgroup 1 discussed broad range of ethical principles and approaches applicable to living and non-living entities on Earth (e.g., intrinsic worth/non-worth; utilitarian vs. instrumental values; moral agency, status; virtue ethics, stewardship; functioning biospheres; deontology [golden rule]; protection of science vs. protection of indigenous life and environments, etc.) and agreed they are all useful in thinking about comparative ethics beyond Earth. However, in discussing ethical foundations applicable to space and 'other' life, the subgroup acknowledged that scientists and ethicists approach the topics in very different ways that complicate discussions—even using different language and vocabularies for their analyses about life (e.g., life as something of intrinsic value vs. life as a contaminant or biosafety concern). Due to the short time available at the workshop, it was clear that further analysis by experts would be needed to determine more specifically how ethical considerations might apply to extraterrestrial life, environments and non-living entities. Moreover, it was deemed unlikely that any single approach would apply to all the questions at hand. Thus, a comprehensive analysis is a precursor to development of policy revisions.

In its discussions, Subgroup 2 used an approach that built on definitions of intrinsic vs. instrumental values of entities and how they might be considered from different perspectives (anthropocentric, bio-centric, or eco-centric). Their discussions took a more analytical and operational approach, considering how (or if) instrumental vs. intrinsic values might be applied on different bodies in the solar system-- those with or

without indigenous life, and those where humans might go. This analytical approach allowed the group to identify areas of agreement and disagreement in interpretations about ethical value, and highlighted the need for more detailed deliberations beyond the workshop itself. The group also acknowledged that other perspectives and approaches could be used in considering ethical questions beyond Earth. The subgroup urged adoption of the Precautionary Principle and further investigation of ethical foundations before human interference might cause harm to Earth and other extraterrestrial bodies, including life, ecosystems and biotic and abiotic environments.

Question 2. What revisions or additions to current COSPAR planetary protection policies would be necessary to address these additional considerations/ protections?

The two groups agreed that revisions or additions to planetary protection policy are necessary to address ethical concerns, but there should be no attempts to revise the Outer Space Treaty language itself by modifying either Article IX (planetary protection provisions) or Article VI (liability provisions). Proposed revisions to integrate ethical considerations can likely be accomplished through COSPAR and its long-standing review and advisory processes, similar to the way that other changes to PP policy have been made over the decades. However, each subgroup suggested distinctly different revisions, which were discussed in the plenary session.

- Subgroup 1 suggested that policy revisions to integrate ethical principles and considerations could be accomplished by modifying COSPAR Policy language, which already touches upon relevant issues such as harmful contamination, diverse celestial bodies, and varied activities and operations. The group suggested the addition of new wording related to the value of life and non-living things, including extraterrestrial life and celestial bodies (see below for suggested modifications *italicized and underlined*). These modifications to the existing Planetary Protection Policy would indicate that:

COSPAR acknowledges that:

life, including extra-terrestrial life, has special ethical status and deserves appropriate respect because it has both intrinsic and instrumental values, and

non-living things, including extraterrestrial things, likewise have value and deserve respect appropriate to their instrumental, aesthetic or other value to human or extraterrestrial life,

and accepts that for certain space mission/target body combinations undertaken for scientific, exploration or other purposes by any entity, controls on contamination shall be imposed in accordance with a specified range of requirements based on the following policy statement:

The conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized. In addition, the Earth must be protected from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from an interplanetary mission. *Inherent in the conduct of scientific, exploration and other activities—whether by robotic or human missions—is the need to consider and appropriately protect potential extraterrestrial life. Additionally, there is the need to consider and appropriately protect the Moon and other celestial bodies.* Therefore, for certain space mission/target planet combinations, controls on contamination shall be imposed, in accordance with issuances implementing this policy. (DeVincenzi et al. 1983; COSPAR PP Workshop 2008; ESA PPWG 2008; *Rummel et al., 2010 COSPAR Workshop.*)

- Subgroup 2 suggested that policy revisions should be made for different target bodies based on whether there were indications of indigenous life or not, and whether human explorers were involved. Their approach suggested consideration of varied scenarios and contexts-- including environmental stewardship at the whole body level; management and preservation schemes for large designated areas; and development of human mission requirements for different target bodies. Specifically, they suggested the following detailed policy measures as a way to implement ethical considerations:

- **For Bodies in our Solar System with *no indications of indigenous life.*** (e.g., Moon, NEOs, Mars’ moons, Mercury).

Measures:

Consider environmental stewardship for these bodies in addition to any existing regulations aimed at preventing planetary contamination.

Designation of whole bodies that can be preserved in their pristine conditions for future generations (e.g. for science investigations or other public use)

Definition and designation of certain regions for special protection or management (e.g. fully protected areas or “planetary parks” managed in analogy to Wilderness Act and Antarctic Treaty regime)

- **For Bodies that have *the potential of extant/extinct indigenous life.*** (e.g., Mars, Europa, Enceladus, Ganymede, TBD).

Measures:

Consider environmental stewardship for those bodies in addition to any existing regulations aimed at preventing planetary contamination.

Preservation of the pristine conditions of indigenous ecosystems until they are sufficiently explored

Develop regulations for investigating, affecting and utilizing indigenous ecosystems or their entities,

Definition and designation of certain regions for special protection or management (e.g. fully protected areas or “planetary parks” managed in analogy to Wilderness Act and Antarctic Treaty regime)

- **For Bodies in our Solar system where humans may go.** (e.g., Moon, NEOs and Mars, Mars moons).

The group endorsed the existing COSPAR planetary protection principles and guidelines for human missions and also suggested the following

Measures:

Develop comprehensive and carefully phased policies for human missions to various destinations, encompassing diverse stakeholder interests and considering important ethical values (e.g., environmental management protocols, stewardship strategies for pre-landing, post-landing and post-discovery, etc.)

Develop Pre-Detection Policy for ET Life: (e.g. precursor mission needs).

Create a list of special areas (parks) designated for scientific research purposes only, and under stipulated contamination control measures

Continue research on questions of importance for development of more precise PP policy (e.g., extent of human mission contamination dispersal; efficacy of telerobotic exploration strategy; develop post-life detection policy and quarantine requirements; address issues of co-existence with ET life, ISRU, environmental stewardship, etc.)

Question 3. Would a convention on planetary protection/harmful contamination extending Article IX of the UN Outer Space Treaty (in the manner of the Convention on Biodiversity) be feasible/desirable as a way to provide for elaborations of expanded planetary protection policies?

Both subgroups felt that there are numerous ways to accomplish changes or elaborations to policy that would address concerns about planetary protection and harmful contamination. Both subgroups agreed that no single option should be endorsed at this time. The subgroups felt strongly that any modifications to policy should be handled without changing the scope of the UN Outer Space Treaty and without involving changes in intergovernmental agreements.

- Subgroup 1 suggested that the recently enacted orbital debris agreements might provide a useful model for developing a multi-stakeholder, science-based approach to planetary protection and contamination avoidance. It was the group's consensus that working within the current OST and COSPAR frameworks would likely be more effective than developing any new legal instrument.
- Subgroup 2 considered the option of a convention on planetary protection and also explored a number of other legal approaches during their discussion. The group urged that no attempts be made to modify existing treaties, and felt that the OST already provides an obligation for States to authorize and supervise space activities, and to consider liability for damages, which might be extended to address environmental damages. The group also suggested that requirements for environmental impact assessments (similar to those used with the Antarctic Treaty regime) should be considered for celestial bodies. Finally, the group recommended the establishment of an intergovernmental mechanism and/or body for management of space exploration and use and consideration of stewardship strategies. COSPAR should propose management guidelines to the UN COPUOS in collaboration and coordination with other international bodies (e.g., National Academies, IISL, IAA etc.), similar to the way that space debris guidelines were developed and adopted internationally (UNOOSA, 2010).

Question 4. What revisions or additions to current planetary protection policy should be considered in support of such a broader engagement/dialogue, if any?

Neither subgroup addressed details of this question in their deliberations, but both acknowledged it was important to address. It became apparent in discussions that *how* to integrate ethical considerations into policy actually has two distinct focal areas: 1) current planetary policy aimed at avoiding biological contamination and interference with science exploration (target bodies and control measures), and 2) addressing the policy gap in the realm of environmental management and contamination control for all activities and users of celestial bodies. There was a general agreement that planetary protection policy as currently implemented should remain separate and focused on science, target bodies and contamination control measures. The suggestion was made that an entirely separate and parallel policy is needed to address environmental management of large areas and/or entire bodies.

Question 5. How should we best provide for public engagement in solar system exploration, and involve the public in a dialogue about the ethical aspects of planetary protection?

- In discussions about public engagement and dialogue, Subgroup 1 acknowledged the societal dimensions of science, the responsibility of scientists to consider impacts of their work, and the importance of communicating broadly with the public about the ethics of planetary protection. Rather than endorsing any modification of COSPAR policy to require public engagement, the subgroup felt it would be better for States and members to proactively initiate and sustain their own national or

multinational efforts on broader public dialogue and involvement. In addition to listing several ideas for consideration, including a workshop on public engagement, the group also suggested that an overall communication strategy should be developed jointly by both subgroups, by having the communications specialists in each subgroup work together.

- Subgroup 2 likewise felt that public should contribute to shaping space policy, just as they do in other complex policy areas such as biotechnology, nanotechnology, neuroscience etc. Indeed, public participation in the formation of science policy might be considered a hallmark of success. The subgroup proposed urging COSPAR to encourage its members and the associated States to engage in broad public consultation concerning ethical issues in space exploration, with the ultimate purpose of making public sentiment (including public perception) integrated appropriately into their policy deliberations.

Linda Billings and Susanna Priest worked together to develop a Joint Communications text for consideration by the final plenary session. They focused on the ethics of making policy as well as broadening and sustaining dialogue (see section 6.5 below).

Question 6. Is now a good time to be working on this? If not, then when?

- Subgroup 1 felt that now is the time to discuss ethical concerns and policy revisions, in advance of any discovery of extraterrestrial life or great increase in exploration activities. The group also addressed the question of time related to scientific concerns about long-term obliquity cycles on Mars (>500 yrs.), which has implications for policy statements about habitability and harmful contamination. The group suggested eventual revisions in the wording of planetary protection policy to include specific mention about the timeframe of concern for contamination by human or robotic activity.
- Subgroup 2 did not make any specific suggestions regarding time, but was clearly supportive of further deliberations about policy revisions and public engagement, and suggested the need to continue working on these ethical and policy topics along with ongoing science exploration.

5. Final Consensus Recommendations

After further discussion, the workshop participants reached a set of collective recommendations, which integrated ideas from tutorials, subgroup sessions and plenary deliberations. Participants voted to accept these as their final consensus workshop recommendations:

Recommendations on Expansion of Planetary Protection Policy

All participants agreed that it would be important as an initial step to advocate an appropriately expanded framework for COSPAR Planetary Protection policy/policies to address other forms of “harmful contamination” that go beyond biological and organic

constituent contamination. Moreover, it is important to maintain the existing, effective PP policy while examining in parallel how to address issues of ethical considerations related to life non-life, environmental management, and multiple uses.

Thus, the participants voted to adopt the following recommendations regarding the expansion of planetary protection policy, and to convey them to COSPAR for their further consideration and action:

Recommendation 1: *An expanded overall framework for COSPAR Planetary Protection policy/policies is needed to address other forms of ‘harmful contamination’ than currently addressed (i.e., biological and organic constituent contamination). Such policy framework should be developed within the scope of the U.N. Outer Space Treaty (Article IX on harmful contamination).*

Recommendation 2: *COSPAR should maintain the current policy on biological planetary protection virtually intact, under an expanded framework/umbrella for overall protection policy*

Recommendation 3: *COSPAR should add a separate and parallel policy to provide guidance on requirements/best practices for protection of non-living/non-life-related aspects of Outer Space and celestial bodies.*

The participants also discussed the timeframe of concern for potential harmful contamination, noting that obliquity cycles and long term changes in celestial environments may impact habitability (especially on Mars). The topic was deemed beyond the focus of the workshop, yet needing further consideration. In light of continuing uncertainties about the existence of extraterrestrial life, and the potential survivability of terrestrial microbes on Solar System bodies, the participants agreed that the timeframe of concern for planetary protection and harmful contamination should be considered in more detail. In the meantime,

Recommendation 4. *COSPAR should consider that the appropriate protection of potential indigenous extraterrestrial life shall include avoiding the harmful contamination of any habitable environment—whether extant or foreseeable—within the maximum potential time of viability of any terrestrial organisms (including microbial spores) that may be introduced into that environment by human or robotic activity.*

Integrating Ethical Considerations into COSPAR Planetary Protection Policy Statements

In order to begin the process of integrating ethical considerations into an expanded COSPAR Planetary Protection Policy framework, the participants agreed to recommend the specific changes in COSPAR wording related to life and non-life, including extraterrestrial life and the contamination and disturbance of celestial environments.

Recommendation 5: In the COSPAR PREAMBLE on planetary protection, add wording (*italics*) to acknowledge the values of life, and non-living things as follows :

- referring to COSPAR Resolutions 26.5 and 26.7 of 1964....
- notes with appreciation and interest the extensive work done by the Panel... and its successors... and the Panel on Planetary Protection and
- *acknowledges that*
 - *life, including extra-terrestrial life, has special ethical status and deserves appropriate respect because it has both intrinsic and instrumental values, and*
 - *non-living things, including extraterrestrial things, likewise have value and deserve respect appropriate to their instrumental, aesthetic or other value to human or extraterrestrial life*
- *and accepts that for certain space mission/target body combinations undertaken for scientific, exploration or other purposes by any entity, controls on contamination and restrictions on modifications of the natural state of solar system bodies shall be imposed in accordance with a specified range of requirements based on the policy statements associated with each specific policy.*

Additionally, to address issues of concern about potential extraterrestrial life in the context of current policy on biological planetary protection concern, add wording (*italics*) to the policy statements as follows:

- The conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized. In addition, the Earth must be protected from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from an interplanetary mission. *Inherent in the conduct of scientific, exploration and other activities—whether by robotic or human missions—is the need to consider and appropriately protect potential extraterrestrial life.* Therefore, for certain space mission/target planet combinations, controls on contamination shall be imposed, in accordance with issuances implementing this policy. (DeVincenzi et al. 1983; COSPAR PP Workshop 2008; ESA PPWG 2008, *Rummel et al., 2010*).

Finally, to address parallel concerns about contamination and environmental disturbance to non-living aspects of the Moon and other celestial bodies, the participants noted the need to add/modify wording to policy statements as follows (*italics*):

- *Inherent in the conduct of scientific, exploration, and other activities—whether by robotic or human missions—is the need to consider and appropriately protect the Moon and other celestial bodies. Therefore, for certain space mission/target planet combinations, controls on contamination and environmental disturbance shall be imposed, in accordance with issuances implementing this policy.*

Considering Frameworks for Developing Parallel Policy on Environmental Management and Protection

Participants acknowledged the variety of possible frameworks that could be adopted in the development of a future parallel policy for environmental management and stewardship on the Moon and other celestial bodies. Recognizing that further examination and deliberation was warranted before recommending a preferred path, they agreed to the need for continued study.

Recommendation 6. In order to make progress towards developing and refining the parallel policy described above, there should be continued study over the next several years of various useful structures and frameworks that could incorporate scientific input on one end, and enforcement on the other, considering such possible options as:

- Environmental impact assessments for screening activities on celestial bodies
- An intergovernmental mechanism for management of space exploration and use,
- Ensuring that COSPAR and other groups have input on management guidelines, through a scientific committee providing advice to a Convention or appropriate process/structure
- Possible designation, establishment and monitoring of planetary parks, and areas for other uses, both protected and not-protected, and
- Determine the appropriate jurisdiction over planetary eco-synthesis or other atmosphere-modification schemes, where science and other uses might be threatened or in conflict.

Need for Further Analysis and Discussion

During this time of reanalyzing planetary protection policy, the participants agreed that a conservative approach is warranted. The Precautionary Principle calls for further investigations before interference that is likely to be harmful to Earth and other extraterrestrial bodies, including life, ecosystems, and biotic and abiotic environments.

Recommendation 7: COSPAR should set up a group (or future workshop) to further explore the ethical values (e.g., intrinsic and instrumental) that apply to life, non-life, and environments as well as to the different classes of target objects in our solar system in order to provide guidance for balancing the different interests. Additional details on what this workshop comprises will be developed at future COSPAR Assemblies.

Process for Exploring/Accomplishing Desired Changes in Policy

(e.g., Considering a Convention on Harmful Contamination)

During the plenary session, participants discussed a variety of management options that could be useful in accomplishing the needed changes in policy. John Rummel proposed a strawman approach for initiating development of a workable framework for planetary protection policy—suggesting it might be useful to work towards a Convention on “harmful contamination” of Outer Space and its prevention, with the goal of defining, extending and implementing international law based on an elaboration of Article IX of the UN Outer Space Treaty. Such a convention might be done in a manner similar to the Convention on Biodiversity, which led to a comprehensive structure that includes scientific input on one end, and enforcement on the other.

Participants briefly discussed a variety of other management options and policy approaches. These included environmental impact assessments and pre-screening of activities; designation and monitoring of special areas on target bodies; establishment of space stewardship and environmental regulations; development of an intergovernmental mechanism and/or body to provide for regulation of space exploration and use.

Since members of both subgroups felt that a variety of policy methods and processes should be considered in greater detail, participants agreed that it would be important to study the possible procedural steps and management models over *the next several years and return later with specific recommendations regarding possible ways to accomplish the desired changes in policy. The plenary group felt it would be inadvisable to recommend a particular type of model (e.g. a Convention) at this time.*

Recommendation 8: COSPAR should elaborate on management guidelines in interaction with organizations such as IISL and others, to establish a framework for environmental stewardship on celestial bodies for submittal to the UN COPUOS for UN General Assembly consideration. This should apply additionally to the accepted regulations for preventing harmful planetary contaminations, which currently only consider biological and organic chemical contaminations. This could include the establishment of an intergovernmental mechanism and/or body that provides management of space exploration and use.

Communication, Public Engagement and Dialogue about the ethical aspects of space exploration and planetary protection. As part of its recommendations on matters related to Communications and Public Engagement, the participants noted the following points:

- COSPAR should encourage its members and associated states to initiate and sustain a broad-reaching public dialogue about the ethical aspects of space exploration and planetary protection and to conduct public engagement and public consultation efforts at national and/or regional levels concerning ethics in space exploration.
- COSPAR policy regarding space exploration and the preservation of outer space environments should take into account and reflect the international trend toward sincere consultation with a broad range of publics about the ethical and policy issues associated with space exploration, as has been put into practice for consultation

about developments in biotechnology, nanotechnology, neuroscience, and so on, in both Europe and the United States and Canada.

- Toward addressing the challenges of assessing and incorporating public opinion in policy and planning, COSPAR should ask its Panels on Planetary Protection (PPP) and Space Exploration (PEX) to hold a workshop involving relevant experts on public engagement, consultation, and participation in public policy making. The purpose of this workshop is to inform members about the premises, principles, and purposes of public engagement activities, and to disseminate best practices.

The participants recommended that communications, public engagement and dialogue should be incorporated into upcoming deliberations about changes to planetary protection policy:

Recommendation 9: COSPAR should encourage its members and the associated states to undertake public dialogue and engagement efforts at the national and/or regional level concerning ethics in space exploration, with the ultimate purpose of having public sentiment (including public perception) integrated appropriately into COSPAR policy deliberations. In addition, COSPAR should ask the PPP and PEX groups to hold a workshop on public engagement, consultation, and participation in policy-making in order to inform members about the premises, principles, and purposes of public engagement activities and best practices.

6. Concluding Summary

This Workshop provided a number of perspectives for its participants, and has resulted in an important and useful understanding of the intersections between science protection, practical self-defense, the utility of exploration and expansion into outer space, and the aesthetics and morality of humans relating to the physical (and perhaps biological) aspects of the natural universe. As an organization dedicated to scientific research, COSPAR has an historical role in the use of outer space to extend human knowledge, and has long-espoused a policy that such research (especially when it might involve extraterrestrial life) should be done safely, but it is only recently that COSPAR has determined its role in the use of outer space for other purposes, and a consideration of how far that role takes it into moral and aesthetic considerations.

Because of this Workshop, with its results presented to Panel on Planetary Protection at the Bremen Assembly of COSPAR in 2010, a number events have taken place within COSPAR and without. In one area, it was determined that further discussion of changes to the COSPAR planetary protection policy should take place at the 2012 COSPAR Assembly in Mysore. At Bremen, a further COSPAR workshop on “Development of Foundational Ethical Principles Applicable to Planetary Protection and Space Exploration,” was approved, to be developed with other organizations which have a broader humanistic perspective than is natural for COSPAR. Additionally, the Workshop was reported at a COSPAR-led COPUOS Symposium on “Planetary Protection and

Space Exploration.” Finally, in direct response to the public communications and awareness goals proposed by the Workshop and affirmed by the Panel on Planetary Protection in Bremen, the COSPAR Bureau took concrete steps to increase awareness of COSPAR’s role in this critical area, and to cover an initial period of 6 years allocated €51,500 for that purpose. Elsewhere, international efforts to provide for the protection and use of outer space environments are gaining momentum. The future of planetary protection should be an interesting one, and its direction will be positively affected by the results that were discussed and described as part of this Princeton meeting.

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Agenda A: Workshop Agenda

Agenda Workshop on Ethical Considerations for Planetary Protection in Space Exploration Aaron Burr Hall, Room 219 – Princeton University – Princeton, NJ

Day 1 – 8 June 2010

- 9:00 am Welcome to the workshop and overview John Rummel, COSPAR/ECU
- 9:15 am Short introductions of attendees All
- 9:30 am Science & ethical considerations? An introduction J. Rummel
- 9:45 am Prospects for extraterrestrial life in the Solar System Chris Chyba, Princeton
- 10:15 am The case for human exploration and settlement in the Solar System
Chris McKay, NASA Ames
- 10:45 am Break
- 11:00 am Current law protecting “Outer Space” Joanne Gabrynowicz, U. of Mississippi
- 11:30 pm An alternative model for environmental protection: the Antarctic Treaty System
Armel Kerrest, Univ. of Brest
- 12:00 pm PREVCOM: Protecting Mars from forward contamination David Paige, UCLA
- 12:30 pm Discussion All
- 1:00 pm Lunch
- 2:30 pm Implementing current policy on NASA & ESA missions C. Conley, NASA HQ
- 3:00 pm Invited paper (Environmental protection: Biodiversity Convention)
- 3:30 pm Break
- 3:45 pm A planetary park system for Mars Gerda Horneck
- 4:15 pm Various ethical considerations in space exploration
Carol Cleland, Elspeth Wilson, et al.
- 5:00 pm Discussion
- 6:00 pm Adjourn
- 6:30 pm Reception at Palmer House Dining Room, One Bayard Lane

Day 2 – 9 June 2010

- 9:00 am Welcome to the workshop and overview of Day 2 J. Rummel, COSPAR/ECU
- 9:15 am The role of COSPAR’s Panel on Planetary Exploration
Pascale Ehrenfreund, GWU

Agenda A: Workshop Agenda

9:45 am [End of Open Session] Charter for group discussions and questions J. Rummel

10:15 am Break

10:30 am Group discussions on Workshop questions
(Group 1, Rm 219; Group 2, Rm 216) All

12:30 pm Lunch

2:00 pm Continue group discussions All

4:00 pm Group 1 summary presentation & discussion, Group 1 Chair
Margaret Race, et al.

5:00 pm Group 2 summary presentation & discussion, Group 2 Chair
Gerda Horneck, et al.

6:00 pm Adjourn for the day

Day 3 – 10 June 2010

9:00 am Welcome to the workshop and overview of Day 3 J. Rummel

9:15 am Policy, legal, and ethical landscapes from Groups J. Rummel

10:00 am Discussion of policy, legal, and ethical landscapes All
(Considerations for planets & other bodies, with and without life,
types of missions; time horizon, etc.)

10:30 am Break

10:45 am Discussions continue All

12:00 pm Lunch

1:00 pm Potential Workshop recommendations J. Rummel

1:30 pm Smoothing of major recommendations All

2:30 pm Writing assignments for final report All

3:00 pm Discussion of next steps & proposed COSPAR policy changes for Bremen All

4:00 pm Adjourn

Appendix B: Workshop Subgroup Charter

We are seeking to determine whether the planetary protection measures and other current practices intending to preserve scientific investigations into life and organic chemical evolution should be extended to protect other aspects of planetary environments within an ethical and practical framework that goes beyond “science protection?” If so, what would be the bases for such an ethical and policy framework? What other implications and responsibilities are engendered when seeking to explore outer space in a manner that avoids harmful impacts on potential indigenous biospheres and other aspects of a planetary body?

Questions for Consideration: Please address each question in your report to the plenary, and elaborate your answers to whichever question(s) your group feels are most (more) important.

In addition to the current COSPAR planetary protection policy’s protection of biological/organic-constituent science opportunities, should we conduct solar system exploration to minimize or eliminate other possible negative effects on those bodies, e.g., on:

- Potential (but currently undetected) indigenous biospheres in the farther future (>500 years)?
- Non-living aspects of a body that do not affect scientific study (e.g., historical, scenic, etc.; which?)?
- Other aspects of preservation/stewardship that would make sense to extend into the rest of the solar system?

Which ethical constructs support/require the additional protections? Which might argue against them?

What revisions or additions to current COSPAR planetary protection policies would be necessary to address these additional considerations/protections?

Would a convention on planetary protection/harmful contamination extending Article IX of the UN Outer Space Treaty (in the manner of the Convention on Biodiversity) be feasible/desirable as a way to provide for elaborations of expanded planetary protection policies?

Example additions to the current policy:

- A “reversible” requirement for potential contamination carried by spacecraft? What would that entail (e.g., containment considerations for microbes carried by spacecraft that are not eliminated entirely, etc.).
- A mission-specific impact-statement, similar to the approach taken in the Antarctic Treaty.
- A statement that non-human entities have intrinsic moral status.
- A statement on the ethical implications of NOT exploring space, given the possibility that Earth may be threatened by extraterrestrial influences currently beyond our control (e.g., a large impact event).

Appendix B: Workshop Subgroup Charter

How should we best provide for public engagement with solar system exploration, and involve the public in a dialogue about the ethical aspects of planetary protection?

What revisions or additions to current planetary protection policy should be considered in support of such a broader engagement/dialogue, if any?

Is now a good time to be working on this? If not, then when?

Appendix C: Participant List

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Appendix D: Subgroup Reports

Subgroup 1 Discussion Report

Participants:

Margaret Race, Chair
Jacques Arnould
Linda Billings
Chris Chyba
Steve Clifford
Emily Foote
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Gerhard Kminek
Tullis Onstott
Ted Peters
Petra Rettberg
Elspeth Wilson

Introduction:

We began our session with a brief discussion of the ‘Charter for Workshop Subgroups’, which had been distributed as a guide for addressing the workshop charge. Our focus soon shifted to a number of the key questions.

There was a consensus that we should first consider our bases for formulating an ethical and policy framework that would be consistent with the aims of Article IX of the Outer Space Treaty and its broad notion of “harmful contamination”. We chose to consider the following selected questions in fulfilling our charge:

- a) Looking beyond current planetary protection policy (which is focused on biological contamination to protect scientific investigations), is there a need to conduct solar system exploration in ways that minimize or eliminate other possible negative effects on celestial bodies (e.g., impacts on potential—but currently undetected—indigenous biospheres?) and what time frame is relevant?
- b) What ethical constructs are relevant to support/require the additional protections? Which ethical approaches might argue against them?
- c) What revisions or additions to current COSPAR planetary protection policies would be necessary to address these additional protections?
- d) Is now a good time to be working on this? If not, then when?
- e) Would a convention or special agreement on planetary protection be needed/desirable as a way to accomplishing the desired revisions to policy?
- f) How should we provide for public engagement and dialogue on ethical aspects of planetary protection?

Procedurally, the group decided to be guided by a three-step approach in its deliberations:

- 1) Develop a statement of principles to ground our objectives, clarifying the ethical underpinnings of planetary protection policy as applied to harmful contamination under Article IX of the OST

Appendix D: Subgroup Reports

- 2) Take an operational view of exploration and use, and develop specific recommendations to revise COSPAR language in ways that include considerations of both the ethical framework and harmful contamination.
- 3) Based on the language of the OST and particularly Article IX, indicate explicitly that COSPAR planetary protection policy applies to all space faring nations, to all types of exploration and uses (not just scientific) and to all parties involved in activities (whether governmental or non-governmental entities)

Most of our discussions focused on questions (a) through (d) above, exploring each topic and how it related to the workshop charge and the future of space exploration. Subsequently, we briefly addressed topics (e) and (f), as well as an additional topic (g) of what timeframe should be considered when addressing harmful contamination in the context of COSPAR planetary protection policy. An overview of each discussion area is provided below:

(a). **Looking Beyond Current Planetary Protection Policy:** Considering Article IX of the Outer Space Treaty (OST), we discussed what it meant to protect the planets and other celestial bodies, and whether avoidance of ‘harmful contamination’ applied strictly to biological contamination to protect scientific investigations and scientific activities. Although the notion of harmful contamination has had a decidedly scientific focus as implemented in COSPAR policy, the original Treaty wording is in many ways broader. Discussion explored not only what the OST intends to protect, but also how it applies to space activities in new contexts as we collectively move in new directions. Because the OST covers both exploration and use, it was deemed that notions of stewardship, protection, and contamination avoidance should extend beyond scientific protection, and include activities of all types, regardless whether conducted by government, private, commercial or transnational parties. The main goal should be to protect planets—regardless of who does the activity. The group agreed that as a general principle, commercial activities, whether undertaken by governments, private entities, cooperative international partnerships, transnational corporations, or any other legal form, ought to be required to respect planetary protection constraints (as per Article VI).

(b). **Discussion of Ethical Constructs and Approaches:** As a matter of process, the group determined that a priority goal was to consider what statements of principles and ethical frameworks should underlie any call for modification of planetary protection policy. There was extensive discussion of the various concepts or approaches that are used in ethical deliberations. Among the topics discussed in differing depths were notions of intrinsic worth vs. non-worth, utilitarian/instrumental values, moral agency, moral status, virtue ethics, stewardship, values of functioning biospheres, consequential ethos, deontology, and protection of science vs. protection of life and environments. It became clear that important issues arise from the different ways that scientists vs. ethicists approach these topics, and even what vocabularies are used for their analyses (e.g., scientific value is not the same as ethical value). For example, under current planetary protection policy, earthly life forms are considered potentially harmful contaminants, yet ethicists designate life of all types as having intrinsic value—not dependent upon its use or value by certain groups. Thus, life can be viewed as both a

Appendix D: Subgroup Reports

harmful contaminant as well as something worthy of protection. In essence, current policy attempts two moral jobs, even as it blurs the line between them.

While current policy protects scientists' abilities to test for evidence of possible extraterrestrial life, it is unclear what specific ethical framework should apply to the extraterrestrial life and environments under study. Viewed from the ethicist's perspective, the question is whether extraterrestrial life has only instrumental value for scientific research, or rather an intrinsic value beyond its instrumental value for Earth's scientists. In practice, planetary protection policy for the past four decades has focused on "avoiding" harmful (presumably irreversible) contamination during exploration. There was considerable discussion about a utilitarian approach, debating whether the highest priority should be avoiding or minimizing activities that might jeopardize possible extraterrestrial life and environments or that might interfere with future exploration and uses. It was noted that even on Earth, policies that apply to special places—e.g. World Heritage sites—go beyond utilitarian considerations and recognize rights, values, cultures etc., and call for respecting and honoring far more than just single features of the environment or resource. For considering life beyond Earth, there are questions of how the alleged value of extraterrestrial life relates to the value of life on Earth. Does the category of life-with-intrinsic-value incorporate both terrestrial and extraterrestrial life?

Clearly, there is need for further examination of these fundamental issues, not the least because all the ethical traditions and frameworks, as well as our notions of duties and principles are highly anthropocentric. Thus it is appropriate to analyze more thoroughly how values, meanings and purposes—both scientific and ethical—apply to protection and/or contamination avoidance intended under Article IX. Because clarification of such issues will require further analysis, there was a general consensus that it would be inappropriate to argue for any single ethical approach at this time. The best course of action is to continue to encourage ethical debate about what these ethical principles mean and how they might be applied in particular contexts. Since such deliberations necessarily occur in the context of applied ethics, there can be no clear ethical conclusions drawn up prior to, or in the absence of clear contextual situations.

Although Subgroup 1 chose to focus on broad principles at this time (rather than a single ethical framework), it stressed the importance of clearly acknowledging that both life and potential (undiscovered) life have special ethical status that warrant thinking about duties and obligations toward extraterrestrial life and environments. Regardless of the ethical framework used, the selected approach should be sufficient to continue guiding exploration and activities (of all types) in the coming years, and provide principles applicable in the event that extraterrestrial life is found in the future. It should also be clear about whether and how the principles apply to non-living parts of the environment as well. Because COSPAR and scientists have clearly defined roles in articulating how Article IX and planetary protection policy are interpreted and applied, it is important to ensure appropriate communication with non-scientific stakeholders so they can weigh in on any recommended changes in planetary protection policy and

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application. Presumably this consultation and communication will take place under the auspices of UN Committee on the Peaceful Uses of Outer Space (COPUOS).

(c). **Possible Revisions to Current COSPAR Planetary Protection Policy.** The group also discussed the most effective ways to make changes in current policy in order to address concerns about possible extraterrestrial life, associated biospheres, and non-living features. Discussions centered on the advisability of recommending clearer definition of treaty terms, (e.g., what is contamination vs. harmful contamination? What is exploration vs. use? etc.) vs. making changes through revisions to current COSPAR policy. There was a consensus that we should not change the treaty regime, but rather make adjustments in COSPAR policy itself as a way of extending protection beyond the current narrow focus on biological contamination to protect scientific investigations. The group also suggested the prospect of developing a code of professional conduct analogous to codes of responsibility for doctors, lawyers, human research etc. Because space is the ‘province of all mankind’ and scientists and explorers are part of humanity, the justification for such a code is appropriate to consider at this time, rather than waiting for a time when life may be discovered. No further details about this idea were discussed by the group.

(d). **Timing for Possible Revisions.** Although activities over the past four decades have been dominated by government sponsored scientific research, the increased interest in private sector and commercial activities is likely to lead to other, potentially contaminating activities in the future. Recent discoveries and debates concerning the habitability of martian environments and the prospects for liquid water are illustrative of the need to codify some principles regarding harmful contamination. Since so many missions are already planned, funded, flying, or on-going, it’s likely that exploration and uses of outer space will extend in diverse new directions on multiple celestial bodies in the coming years. Thus, it is appropriate to consider possible revision of COSPAR planetary protection policies in order to realize the intent of Article IX in avoiding harmful contamination. It was agreed that the notion of harmful contamination should be considered not only in relation to potential indigenous life and associated biospheres, but also to non-living parts of the environment of planets and other celestial bodies. In examining planetary protection policy, it is clear that scientists have the opportunity to set a high moral bar for exploration, with the prospect of incorporating broader ethical perspectives where values are considered. (e.g., intrinsic value; rights of non-biological entities to exist, etc.) We have an opportunity to push to a more developed point than found in definitions used over last 100 years (re: public lands, for example.)

(e). **Need for a convention or special agreement on planetary protection:** The group briefly considered the advisability of formulating a special agreement or convention on planetary protection similar to that used for preservation of biological diversity and environmental protection on Earth (as presented by John Rummel in the initial plenary tutorials). Because the OST and planetary protection policy have guided space exploration activities on celestial bodies for over four decades, it was the group’s consensus that working within the current OST and COSPAR frameworks would likely be more effective than developing an entirely new legal instrument.

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(f). **Public Engagement and Dialogue:** The group briefly considered the question of how to provide for public engagement and dialogue on ethical aspect of planetary protection. The rationale for engagement and dialogue was based on an acknowledgement that

- Science has social dimensions, and scientists have social responsibilities. Among those responsibilities are considering the broader impacts of their work on society and communicating with society – that is, a broad spectrum of public audiences – about the work they do, its scientific objectives, and its broader impacts.
- The global space science community shares these responsibilities, and COSPAR has a role to play in helping space scientists to fulfill these responsibilities.
- COSPAR's planetary protection policy provides a focus for efforts to inform the public about space science, planetary exploration, and legal regimes, scientific rationales, and ethical considerations for protecting planetary environments and any life they may support.

The group initially considered the idea of adding language into COSPAR policy that would recommend broad-reaching dialogue on ethical aspects of planetary protection as part of COSPAR policy. Upon further discussion, the group felt that it would be better to suggest varied proactive public communication steps, with details to be developed jointly by communications specialists in Subgroups 1 and 2 (Billings and Priest). Among the ideas suggested for eventual plenary and COSPAR consideration were:

- 1) Endorse the need for initiating and sustaining a broad public dialogue on the ethics of planetary protection;
- 2) Encourage its members to initiate their own national or multinational efforts to engage and involve the broader public in this dialogue on the ethics of planetary protection, including efforts to enable public participation in policy and planning;
- 3) Promote communication about planetary protection as an ongoing, interactive process that is responsive to changing social contexts, encompassing multiple channels of communication, accommodating multiple perspectives, and helping to engender and sustain public knowledge, interest, and trust; and
- 4) Ask its Panels on Planetary Exploration and Planetary Protection to hold a workshop on communication, outreach, engagement and participation as a way of initiating, broadening and sustaining a dialogue about the ethical aspects of planetary protection, and engaging and involving all interested citizens.

(g). **Discussion about the Timeframe of Concern for Harmful Contamination:** With regards to contamination of Mars in particular, some scientists have expressed concern that long-term obliquity cycles could result in changes in conditions on the planet that potentially could make the environment more amenable for extraterrestrial life as well as terrestrial microbes harbored on spacecraft. Since COSPAR policy specifically states that *the conduct of scientific investigation of possible extraterrestrial life forms, precursors and remnants must not be jeopardized*, it is important to include wording that addresses the timeframe of concern for harmful contamination. The following suggested revision—to be discussed in plenary session—was proposed to address this concern:

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The appropriate protection of indigenous extraterrestrial life shall include avoiding the harmful contamination of any habitable environment, whether suspect or extant. The timeframe of concern for such contamination shall be defined by the maximum time of viability of any terrestrial organisms (including spores) that may be introduced into that environment by human or robotic activity.

Specific Findings of Sub-Group 1 to be brought forward for Plenary Discussion:

Based on the discussions outlined above, Sub-group 1 crafted a number of specific statements for discussion in plenary session. If adopted, they could be presented to COSPAR as ways to revise or modify current policy in order to address various ethical considerations. In addition, the topic of the timeframe of concern for harmful contamination would also be discussed in plenary.

I: Statements on Ethical Status of Life and Non-Living Things

The group articulated specific statements related to the ethical status of both life and non-living things as follows:

Life:

Life, including extra-terrestrial life, has special ethical status because it has both intrinsic and instrumental value. For these reasons it deserves appropriate respect.

Life has value for its own sake, for its role in ecosystems, and for its aesthetic value. There is scientific, ethical, and other value in finding and understanding life.

Non-Living Things:

Non-living things, including extraterrestrial things, have value. Therefore, they deserve respect appropriate to their instrumental, aesthetic or other value to human or extraterrestrial life.

The value of non-living things is different than the value of life. Non-life supports life, and other non-life, has aesthetic value, and has value for its own sake.

II. Recommendation on Ethical Principles:

Although the subgroup discussed how to “develop a statement of principles that could ground our objectives and clarify the ethical underpinnings of planetary protection policy as applied to harmful contamination under Article IX of the OST”, we determined it was not advisable or practical during this workshop to suggest a single ethical framework or set of principles for use in planetary protection policy.

The consensus was that further analysis and deliberation will be needed. Moreover, it will be important to incorporate a diversity of cultures, ethical perspectives, and religious traditions in any discussions of this type. Discussions should be undertaken soon – prior to detection of possible extraterrestrial life or significant increases in exploration activities.

III. Recommended revisions in COSPAR Policy language

In proposing specific recommendations for COSPAR policy language, the subgroup tried to formulate revisions that would address many considerations: ethical principles, harmful contamination, diverse celestial bodies, and varied activities and operations.

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The recommendations, which to modify current COSPAR planetary protection policy, are the logical follow-on to the existing preamble of the COSPAR Planetary Protection Policy (20 Oct 2002; Amended 24 Mar 2005; 20 July 2008) which indicates:

PREAMBLE

Noting that COSPAR has concerned itself with questions of biological contamination and spaceflight since its very inception, and

noting that Article IX of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (also known as the UN Space Treaty of 1967) states that:

“States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter, and where necessary, shall adopt appropriate measures for this purpose (UN 1967)

therefore, COSPAR maintains and promulgates this planetary protection policy for the reference of spacefaring nations, both as an international standard on procedures to avoid organic-constituent and biological contamination in space exploration, and to provide accepted guidelines in this area to guide compliance with the wording of this UN Space Treaty and other relevant international agreements”.

Based on its deliberations, Subgroup 1 recommended that COSPAR’s current Policy statement should be modified as follows: (Proposed modifications shown in underlined text):

POLICY

COSPAR,

Referring to COSPAR Resolutions 26.5 and 26.7 of 1964, the Report...of 1966, ... of 1967, and the Report of the COSPAR/IAU Workshop of 2002,

notes with appreciation and interest the extensive work done by the Panel on ... and its successors... and the Panel on Planetary Protection and acknowledges that

life, including extra-terrestrial life, has special ethical status and deserves appropriate respect because it has both intrinsic and instrumental values, and non-living things, including extraterrestrial things, likewise have value and deserve respect appropriate to their instrumental, aesthetic or other value to human or extraterrestrial life, and

accepts that for certain space mission/target body combinations undertaken for scientific, exploration or other purposes by any entity, controls on contamination shall be imposed in accordance with a specified range of requirements based on the following policy statement:

The conduct of scientific investigations of possible extraterrestrial life forms, precursors, and remnants must not be jeopardized. In addition, the Earth must be protected from the potential hazard posed by extraterrestrial matter carried by a spacecraft returning from an interplanetary mission. Inherent in the conduct of scientific, exploration and other activities—whether by robotic or human missions—is the need to consider and appropriately protect potential extraterrestrial life.

Additionally, there is the need to consider and appropriately protect the Moon and

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other celestial bodies. Therefore, for certain space mission/target planet combinations, controls on contamination shall be imposed, in accordance with issuances implementing this policy. (DeVincenzi et al. 1983; COSPAR PP Workshop 2008; ESA PPWG 2008; Rummel et al., 2010 COSPAR Workshop.)

Subgroup 2 Discussion Report

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Preamble

In our discussions we agreed to the following definition of terms.

Intrinsic value refers to a value ascribed to a person, living organism, or other entity that has value in and of itself. **Instrumental value** refers to a value ascribed to a person, living organism, or other entity based on the value to some other, such as a value to humans (anthropocentric), other living organisms (biocentric) or an eco-system (ecocentric). One can take a biocentric perspective, which ascribes intrinsic value to living organisms. This position would seem to imply that one ascribes at least an instrumental value, and perhaps intrinsic value, to an eco-system. Alternatively one may take an ecocentric perspective, which ascribes intrinsic value to an eco-system, but does not necessarily endorse a biocentric perspective.

The **Precautionary Principle** calls for further investigations before interference that is likely to be harmful to Earth and other extraterrestrial bodies, including life, ecosystems, and biotic and abiotic environments.

We recognize there are other perspectives not included in the above definitions.

Ethical considerations for the different targets in our solar system

- **Bodies in our Solar System with no indications of indigenous life.**
Group disagreement on intrinsic value of non-living things; however non-living things warrant consideration in the context of PP, at least from an instrumental value perspective.

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- **Bodies that have the potential of extant/extinct indigenous life.**

Group agreement on intrinsic value of all life. New concept of “bio-ecocentrism”: both life and ecosystems have intrinsic value. Instrumental value from an anthropocentric perspective is different from instrumental value for alien ecosystems.

- **Solar system bodies where humans go.**

(a) **bodies with putative life.** Promote flourishing of all life as a guiding ethical principle. There was Group agreement that ‘promoting the flourishing of all life’ meant protecting extraterrestrial organisms and ecosystems so that they continue to flourish during and after space missions. However, the Group disagreed concerning whether ‘promoting the flourishing of all life’ also established a further moral obligation to restore life that was declining through indigenous evolutionary processes—or creating life where none currently existed. It then becomes necessary to carefully balance the interests of humans and alien ecosystems (balanced coexistence). Consider situation where Martian living organisms would be dangerous to humans (if co-existence is not possible). What would be the position of an ethical space-faring species? Need to adopt a phased approach; parks concept.

(b) **bodies without life.** What is their intrinsic value? Or can we only judge in terms of instrumental value (e.g. historical, scientific, aesthetic, commercial)? There should be assessments to assign relative weight to various instrumental values, and appropriate formal mechanisms to implement these assessments.

- **‘Cosmic (or meta) golden rule’: do not do unto someone/something else that you would not want them to do unto you (孔夫子)**

Implementation of these ethical considerations

- **Bodies in our Solar System with no indications of indigenous life.** These bodies have potential instrumental values, such as:
 - historical (e.g. landing spots)
 - scientific (e.g. water ice, geological features, unperturbed exosphere measurements, outposts, ISRU & LSS)
 - aesthetic (e.g. scenic landscape “magnificent desolation”, environmental management)
 - cultural (e.g. archiving of human knowledge and biosphere)
 - exploration (e.g. outposts, human settlements)
 - commercial (e.g. minerals extraction, ISRU & LSS, infrastructure development & management, tourism)

Target bodies: Moon, NEOs, Mars moons, Mercury

Measures:

COSPAR and other bodies should consider environmental stewardship for those bodies additionally to accepted regulations for planetary contaminations:

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Definition of whole bodies that can be preserved in their pristine conditions for future generations, e.g. science investigations or other public use

Definition of certain regions, e.g. fully protected areas or “planetary parks” that are managed in analogy to wilderness act and Antarctic treaty regime.

- **Bodies that have the potential of extant/extinct indigenous life.**

These bodies have intrinsic values, if they are an abode of indigenous life, regardless whether that life is different from Earth life (second genesis) or based on the same biochemistry (same origin as Earth life), active or dormant.

They have also an intrinsic value at the ecosystem level (e.g. potential subsurface communities, marine communities, permafrost communities)

These bodies have also instrumental values, such as:

scientific (e.g. comparative universal biology, achieving a more general understanding of life, understanding our own history, global climate changes, comparative planetology)

technology (e.g., efforts to protect ecosystems, efforts to “help the ecosystems to flourish”)

aesthetic (e.g., scenic landscape, unique geological feature, e.g. geysers)

commercial (e.g., TBD)

Target bodies: Mars, Europa, Enceladus, Ganymede, TBD

Measures:

COSPAR and other bodies should consider environmental stewardship for those bodies additionally to accepted regulations for preventing planetary contaminations:

Preservation of the pristine conditions of indigenous ecosystems until they are sufficiently explored

Regulations for investigating, affecting and utilizing indigenous ecosystems or their entities

Definition of certain regions, e.g., fully protected areas or “planetary parks” that are managed in analogy to Wilderness act and Antarctic Treaty regime.

- **Solar system bodies where humans go.**

These bodies have potential intrinsic and instrumental values, such as:

historical (e.g. landing spots)

scientific (e.g. life, human biological and psychological research?, water ice, geological features, unperturbed exosphere measurements, outposts, ISRU & LSS, terraforming?)

aesthetic (e.g. life-forms, scenic landscape, environmental management, terraforming?)

cultural (e.g. inspiration, new “branch” of human culture, “experiment” with social systems and organization, archiving of human knowledge and biosphere)

exploration (e.g. live and work in space, short duration sortie missions, longer temporary missions, recon for future activities, resource discovery)

commercial (e.g. expanding human economic sphere, minerals extraction, ISRU & LSS, infrastructure development & management, tourism)

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long-term human survival (e.g. “Insurance policy” against human extinction and longer-term development of all of the above: e.g. large sustainable human settlements, human migration, self-sustaining human settlements.

Target bodies: Moon, NEOs and Mars, Mars moons

Measures:

The group endorses the guidelines for Human missions already established by present COSPAR policy:

“A comprehensive planetary protection protocol for human missions should be developed that encompasses both forward and backward contamination concerns, and addresses the combined human and robotic aspects of the mission, including subsurface exploration, sample handling, and the return of the samples and crew to Earth.”

Comprehensive and carefully phased policies, such as environmental management protocols or stewardship strategies for pre-landing, post-landing and post-discovery phases, should be developed for human missions to various destinations and should encompass and balance a diverse set of stakeholder interests – as represented by a range of intrinsic values and instrumental values.

Develop Life Pre-Detection Policy: (e.g. precursor mission needs).

Create a list of special areas (parks) that are for scientific research purposes only. Humans may only go into these areas if prevention of harmful contamination is demonstrated earlier (e.g., Mars special regions). Same for robotic and tele-robotic missions. Humans can then go once sufficient science has been done.

Address the following research questions for more precise policy development: Could contamination from the first human mission be transported globally? If so, is it problematic? (e.g. threatening to life, mask indigenous life)

Study telerobotic exploration from Mars moons as a planetary protection strategy (part of precursor phase?)

Develop Life Post-Detection Policy: what do we do once life is discovered

Tell everyone, share information

Quarantine (modalities)?

Co-existence - but need to have prior TBD level of confidence that co-existence is feasible.

ISRU management, see environmental stewardship

Find out whether crew health and safety and contaminated crew protocol are covered by present COSPAR guidelines

Public engagement:

COSPAR should encourage its members and the associated states to engage in public consultation and public engagement efforts at the national and/or regional level concerning ethics in space exploration, with the ultimate purpose of making public sentiment (including public perception) integrated appropriately into their policy deliberations. Public opinion and public perception should help shape policy in societies for space exploration, as for policies in other areas. The participation of a broad variety of publics in the formation of science (and other complex) policy might be considered a hallmark of success.

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Legal aspects

Do not modify existing treaties.

Article VI of the Outer Space Treaty provides an obligation for States to authorize and supervise space activities.

The liability Convention makes launching states liable for damage. Liability of the launching states could be extended to damage done to the space environment including celestial bodies.

As with the Antarctic Treaty, environmental impact assessments should be required for all activities on celestial bodies.

We recommend the establishment of an intergovernmental mechanism and/or body that provides management of space exploration and use. COSPAR should propose management guidelines, in interaction with national academies and other organizations such as IISL and others, to the UN COPUOS for UN General Assembly consideration. This is similar to the process whereby the UN COPUOS transmitted guidelines developed by the Inter-Agency Debris Coordination Committee to the UN General Assembly. COSPAR guidelines could provide a basis to determine fault for damage in outer space.

OST Article IX states “States Parties to the Treaty shall avoid harmful contamination of the celestial bodies”.

Recommendations of Group 2

1. COSPAR should set up a group (workshop) to further explore the ethical values (intrinsic and instrumental) for the different classes of target objects in our solar system and provide guidance for balancing the different interests.
2. The Precautionary Principle calls for further investigations before interference that is likely to be harmful to Earth and other extraterrestrial bodies, including life, ecosystems, and biotic and abiotic environments.
3. COSPAR should elaborate management guidelines and draft regulations in interaction with national academies and other organizations such as IISL, UN-COPUOS and others to establish a framework for environmental stewardship. This should apply additionally to the accepted regulations for preventing harmful planetary contaminations, which currently only consider biological and organic chemical contaminations.

Comprehensive and carefully phased policies, such as environmental management protocols or stewardship strategies for pre-landing, post-landing and post-discovery phases, should be developed for human missions to various destinations and should encompass and balance a diverse set of stakeholder interests – as represented by a range of intrinsic and instrumental values.

This could include the establishment of an intergovernmental mechanism and/or body that provides management of space exploration and use. COSPAR should propose management guidelines, in interaction with national academies and other organizations such as IISL and others, to the UN COPUOS for UN General Assembly consideration. This is similar to the process whereby the UN COPUOS

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transmitted guidelines developed by the Inter-Agency Debris Coordination Committee to the UN General Assembly. COSPAR guidelines could provide a basis to determine fault for damage in outer space.

4. COSPAR should encourage its members and the associated states to engage in public consultation and public engagement efforts at the national and/or regional level concerning ethics in space exploration, with the ultimate purpose of making public sentiment (including public perception) integrated appropriately into their policy deliberations. Public opinion and public perception should help shape policy in democratic societies for space exploration, as for policies in other areas. The participation of a broad variety publics in the formation of science (and other complex) policy might be considered a hallmark of success.

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Appendix E: Draft Communication Recommendation (combined)

Combined Subgroups 1 & 2 text on communication

The ethics of making policy: broadening and sustaining dialogue

L. Billings and S. Priest

RECOMMENDATION 1: COSPAR should encourage its members and associated states to initiate and sustain a broad-reaching public dialogue about the ethical aspects of space exploration and planetary protection and to conduct public engagement and public consultation efforts at national and/or regional levels concerning ethics in space exploration.

RECOMMENDATION 2: COSPAR policy regarding space exploration and the preservation of outer space environments should take into account and reflect the international trend toward sincere consultation with a broad range of publics about the ethical and policy issues associated with space exploration, as has been put into practice for consultation about developments in biotechnology, nanotechnology, neuroscience, and so on, in both Europe and the United States and Canada.

RECOMMENDATION 3: Toward addressing the challenges of assessing and incorporating public opinion in policy and planning, COSPAR should ask its Panels on Planetary Protection and Space Exploration to hold a workshop on public engagement, consultation, and participation in public policy making, involving relevant experts. The purpose of this workshop is to inform members about the premises, principles, and purposes of public engagement activities, and to disseminate best practices.

Science has social dimensions, and scientists have social responsibilities. Among those responsibilities are considering the broader impacts of their work on society and communicating with society – that is, with a broad spectrum of public audiences – about the work they do, its scientific objectives, and its broader impacts.

The global space science community shares these responsibilities, and COSPAR has a role to play in helping space scientists to fulfill these responsibilities. COSPAR's planetary protection policy provides a focus for efforts to inform the public about space science, planetary exploration, and legal regimes, scientific rationales, and ethical considerations involved in protecting planetary environments and any life they may support.

The scope of communications about planetary protection is broad, encompassing terrestrial and extraterrestrial biology; disease control; environmental protection and ethics; engineering and technology development; national and international law, regulation and policy; risk assessment; and more. Issues in planetary protection include forward and back contamination, technology requirements for containment and analysis, and legal, regulatory, and policy frameworks. Communication about planetary protection must extend not only beyond space science to the broader science and technology communities, but also to governmental and nongovernmental organizations, interest groups and other public audiences.

Appendix E: Draft Communication Recommendation (combined)

With the era of solar system sample return missions already under way and an increasing focus in planetary exploration missions on astrobiology research and the search for signs of water and life on Mars and elsewhere, the importance of planetary protection policy is becoming more apparent. The community of space scientists concerned with planetary protection has a social obligation to explain the science, technology, and risk involved in planetary protection; improve understanding of astrobiology research and planetary exploration goals and plans; sustain an ongoing dialogue with interested audiences; and contribute to the building and maintenance of public trust.

The Workshop participants recognize that communication, education, outreach, and engagement with a wide variety of “publics” play an important role in planning and executing space exploration programs and administering planetary protection policy. Approaching communication as a dialogue can enable more effective communication about science, greater public engagement, more informed public decision-making, and more enduring public trust.

The purpose of public engagement and consultation is to better understand public sentiments and perceptions and ensure that they are integrated appropriately into policy deliberations. Public opinion and public perception should help shape policy and planning for space exploration in democratic societies, as it does for policy and planning in other areas. The participation of a broad variety of publics in the formation of science, technology, and space policy might be considered a hallmark of success.

“Public engagement” is a phrase with broad meaning, generally referring to various means of involving non-expert “publics” (not limited to narrowly defined “stakeholders” but also including such groups as taxpayers, voters, citizens, whose “stakes” are more general) in deliberations about public policy. Public engagement goes beyond traditional outreach activities to encourage a deeper level of involvement. The two primary motivations for public engagement are: 1) to foster the development of public policy that has public support and 2) to enact a fundamental principle of democracy by consulting “the public” about public policy.

Attempting to build public support through engagement may be partially misdirected, however, because there is no guarantee that an “engaged” set of publics will be a “supportive” set of publics. The second motivation stems from the belief that it is an inherent (ethical) good to consult “the public” (in actuality, many publics) about public policy, perhaps especially policy involving substantial expenditures of public moneys or other resources.

The related phrase “public consultation” refers more specifically to taking the opinions of various (non-expert) publics into account in deliberations about public policy. Public consultation is an emerging tradition in both Europe and North America, particularly with respect to science and technology policy. It can range from the conduct of public opinion polls, focus groups, and other “information gathering” exercises, which can be considered weak forms of public engagement, to more active and sophisticated means

Appendix E: Draft Communication Recommendation (combined)

of securing information about informed public sentiment. The latter form of consultation, in its stronger forms, often uses models involving public consultation combined with public education about expert views, such as citizen juries or consensus conferences in which citizens are invited to learn about and to debate relevant issues, as well as to formally express their opinions. Generally, these more sophisticated forms of public consultation are “two-way” and presume that a means can be found both for expert opinion to inform public opinion and for public opinion to inform public policy deliberations. A typical shortcoming of such efforts, however, is that no mechanisms are put in place for injecting public opinion into public policy and advising public participants on the outcome of their participation.

Public engagement and public consultation are not merely forms of market research or persuasion, and public consultation should not be considered a form of propagandizing on behalf of policies predetermined by experts. Ideally, where appropriate mechanisms are in place for public opinion to inform the development of public policy, it is not a foregone conclusion whether or not this opinion will support, or contradict, expert public opinion, even if appropriately informed thereby. The values of various non-expert “publics” are different from the values of the scientific community, for example, which may result in different conclusions on matters of science policy.

On the other hand, it is reasonable to assert that science policy should not necessarily be determined by majority vote. For technically complex issues such those addressed in space or other science-oriented policies, a balance must be struck among the views of the public generally, the views of the informed public, and the views expressed in expert opinion. Achieving this balance represents an unsolved problem in democratic theory and a challenge to policy makers.

There is no concrete precedent for global-scale public consultation, which involves major logistical and other practical challenges – not the least of which is the culturally pluralistic nature of modern societies and the global community. Consultations involving various European nations and consultations across the United States have been attempted, but with difficulty. Consultations on a truly global scale are difficult to envision, as a practical matter, but a goal worth keeping in mind.

Appendix F: Post-Workshop Update (May 2012)

Due to the amount of time that has passed between the completion of the Workshop and the date of this report, a quick update on the status of the Workshop's results and their implementation is considered appropriate.

Activities subsequent to the Workshop:

1. July 2010. COSPAR Assembly:* Margaret Race gave a jointly authored presentation summarizing the activities and recommendations of the COSPAR Princeton Workshop on Ethical Considerations for Planetary Protection in Space Exploration

(* Presented in Session PPP 1⁴—Planetary Protection Policy and Implementation Guidelines-- at COSPAR Assembly in Bremen, Germany).

2. July 2010. COSPAR PPP Business Meeting. Recommendations from the Princeton Workshop were discussed along with other issues on the planetary protection agenda. Because of time constraints, further discussion of the workshop and development of additional resolutions is planned at the 2012 COSPAR Assembly and/or at intervening meetings/workshops in order to allow for further deliberation or study (especially on topics involving changes in COSPAR policy language, suggestions for public engagement, and considering the time frame for harmful contamination)

3. July 2010. COSPAR Workshop Proposed. The PPP Business Meeting at Bremen also agreed to seek approval and baseline funding from the COSPAR Bureau to convene a follow-on workshop and specifically address "Development of Foundational Ethical Principles Applicable to Planetary Protection and Space Exploration." [Note: The COSPAR Bureau and Council subsequently approved the recommended workshop and provided 3000 Euros as baseline funding.]

**** Proposed Workshop Description:** COSPAR Workshop on "Development of Foundational Ethical Principles Applicable to Planetary Protection and Space Exploration." [Co-Organizers: Margaret Race and Jacques Arnould]

The recent COSPAR workshop on Ethics and Planetary Protection (June 2010) identified policy areas having ethical implications beyond those encountered on Earth, and recommended further ethical deliberations to determine what foundational principles should be incorporated into COSPAR PPP and/or PEX documentation to guide scientific and other human activities in the context of the Outer Space Treaty (Article IX: 'harmful contamination').

The proposed workshop will involve 25-30 experts with diverse cultural and disciplinary perspectives who will examine bioethical applications on Earth, and explore what ethical justifications and foundations should apply during space exploration and use of diverse solar system bodies during scientific and other activities. Analyses will build upon the international, intercultural experiences of UNESCO in its bioethical reflections, as well as experiences of the biodiversity convention and other research (e.g., environmental ethics; frontiers between living and non-living). [Agenda and location TBD]

Participants will explore and confront important differences between scientific, philosophical, cultural and ethical perspectives and the ways they are

⁴ PPP = Panel on Planetary Protection

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incorporated into policy formulation. Subgroups will examine the implicit presuppositions that apply to bioethics and policy instruments on Earth, and consider justifications for extending these commitments to life, environments and activities beyond Earth. Analyses will discern what distinct value commitments have already been made on Earth and during space exploration, and what assumptions and coherence these may have in the future.

The workshop report will provide a comprehensive analysis of foundational information and recommendations relevant to the formulation of coherent, justifiable COSPAR policies related to life, planetary environments and the ethics of exploration and use by scientists and others.

4. February 2011. COPUOS Symposium. The results of the Workshop formed a major part of a presentation given to the Scientific and Technical Subcommittee of the UN Committee on the Peaceful Uses of Outer Space (COPUOS) as part of the COSPAR-led *Symposium on “Planetary Protection and Space Exploration.”* The subject of the symposium was COSPAR’s role in the avoidance of harmful contamination in the exploration of the Moon and other celestial bodies, including the protection of other bodies from biological contamination from Earth and the protection of the Earth from introductions of biological agents from space that might have an adverse effect on the Earth’s biosphere. The symposium was organized for COSPAR by the Panel on Planetary Protection (PPP) in cooperation with the Panel on Exploration (PEX), and included planetary scientists and planetary protection experts active in the field. The symposium was held beginning at 1500 in the afternoon at the Vienna International Center on 14 February 2011. The Subcommittee numbered between 65 and 84 members present at all times during the presentations, with a mean of about 75.

5. March 2011. COSPAR Bureau Action. In direct response to the public communications and awareness goals proposed by the Workshop and affirmed by the Panel on Planetary Protection in Bremen, the COSPAR Bureau took concrete steps to enhance the effective promulgation of its Planetary Protection Policy and increase awareness of COSPAR’s role in this critical area. COSPAR determined to provide startup funding to build planetary protection’s internet presence and usability, presentation and print materials, and to conduct agency visits and presentations at international scientific meetings. The Bureau agreed to maintain these efforts for an initial period of 6 years, and allocated €51,500 for this purpose over that period.